

US EPA ARCHIVE DOCUMENT



Comparison of Process Technology

MIDREX vs. ENERGIRON
June 6th , 2013

Goal of Process: Convert Pellets into HBI



Pellets min. 66 % Fe



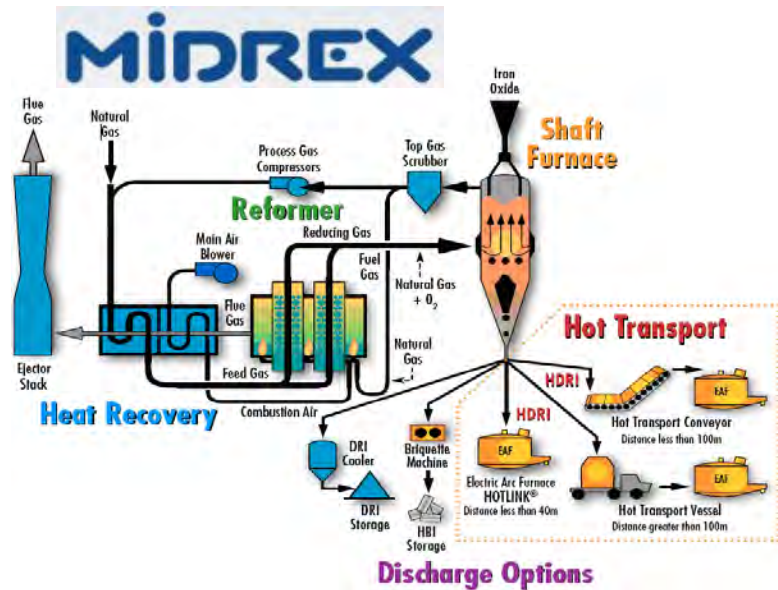
Direct Reduction



HBI min. 91 % Fe
Hot Briquetted Iron



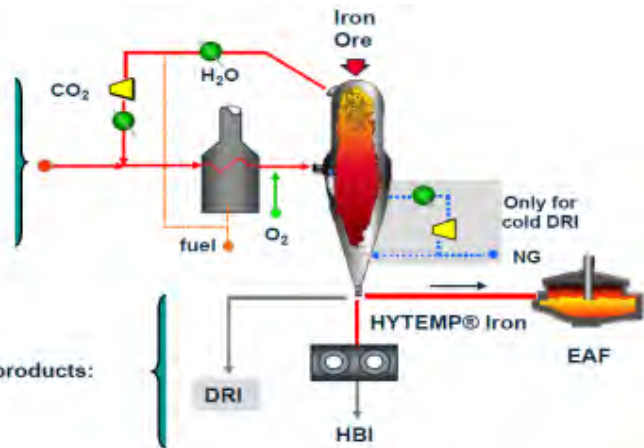
Available Process Technology: MIDREX / ENERGIRON



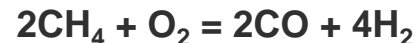
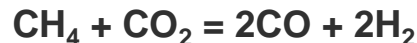
ENERGIRON^{HYL}
THE INNOVATIVE DIRECT REDUCTION TECHNOLOGY

Reducing gases sources

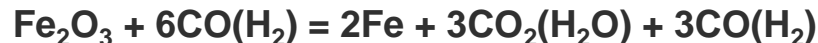
- Natural Gas
- Reformed Gas
- Coal Gasification
- COG
- others



Reducing gas



Reduction process



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Example MIDREX: LGOK



LGOK II (Midrex) : Gubkin, Russland

Capacity: 1,4 Mill. t HBI

Start up: 2007



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| Technology decision

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Example Energiron: Emirates Steel



Emirates Steel (Steam Reformer) : Abu Dhabi, VAR

Capacity: 1,6 Mill. t HDRI

Start up: 2011

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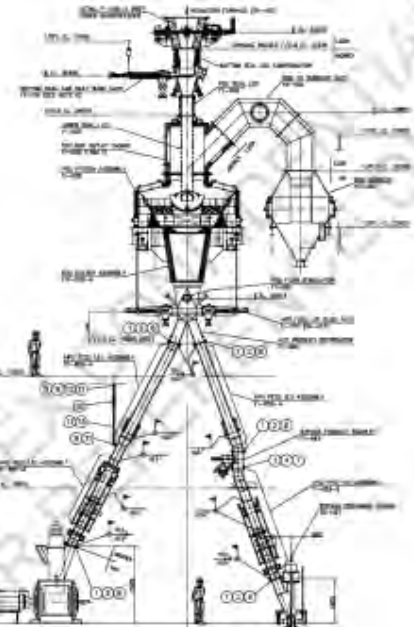
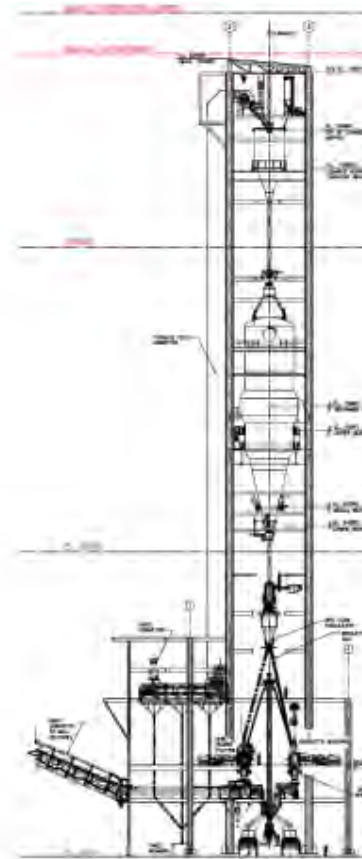
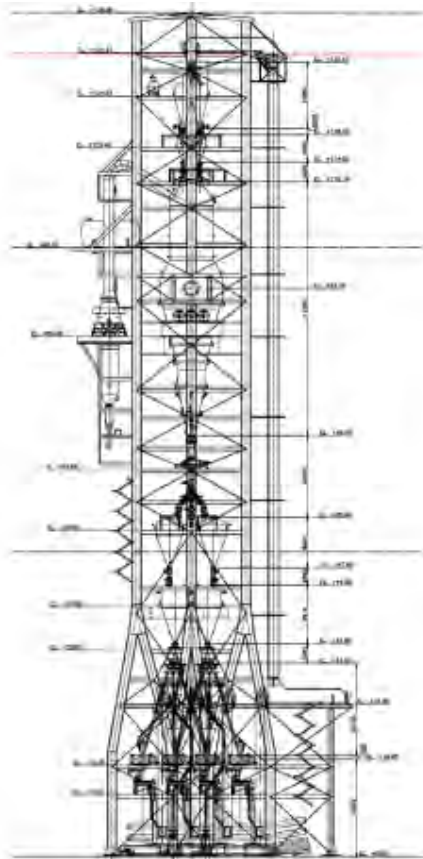
| Technology decision

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Comparison: MIDREX vs. ENERGIRON

	MIDREX/SVAI	ENERGIRON/Danieli
Core Process /HBI	<ul style="list-style-type: none"> Reducing gas from reformer Low pressure level (2 bar), high gas velocity Briquetting process Discharge system HDRI retrofittable 	<ul style="list-style-type: none"> Reducing gas from partial oxidation and in-situ reforming High pressure level (8 bar), low gas velocity Briquetting process Discharge system HDRI retrofittable
Reference units	<ul style="list-style-type: none"> LGOK 2 (1,4 mt HBI) JINDAL Shadeed (1,5 mt HBI) LGOK 3 (1,8 mt HBI, 2015) <p>Design and operation up to 2,0 Mio t DRI/HBI</p>	<ul style="list-style-type: none"> TERNIUM 4M (1,0 mt HDRI) SUEZ (2,0 mt HDRI, 2013) NUCOR (2,5 mt CDRI, 2013) <p>No reference plant Zero Reformer (ZR) in combination with HBI Design and under construction up to 2,5 Mio t DRI</p>
Control range	60-100% of nominal output	60-100% of nominal output
CO2 removal	Part of CO2 is used for the reforming process	Integrated in the ZR process concept

Reactor



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ENERGIRON

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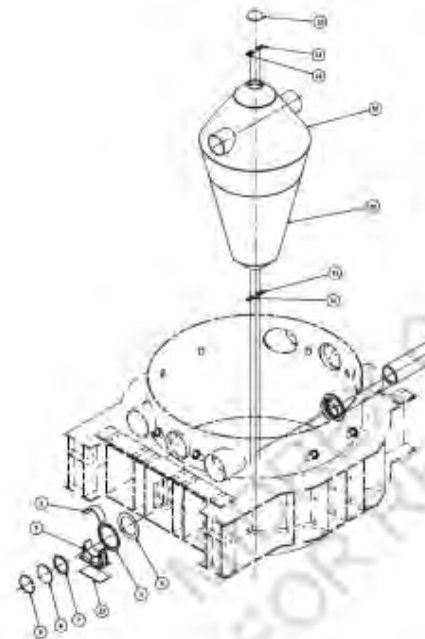
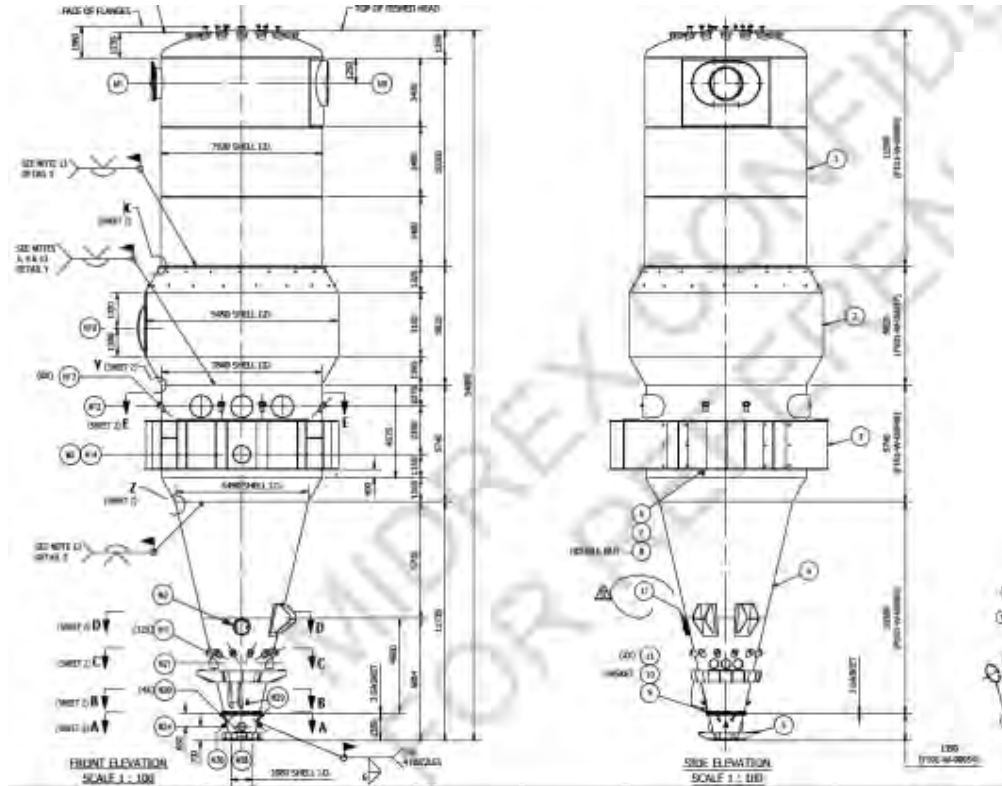
Direktreduktionstechnologie gowest

MIDREX voestalpine

ONE STEP AHEAD.

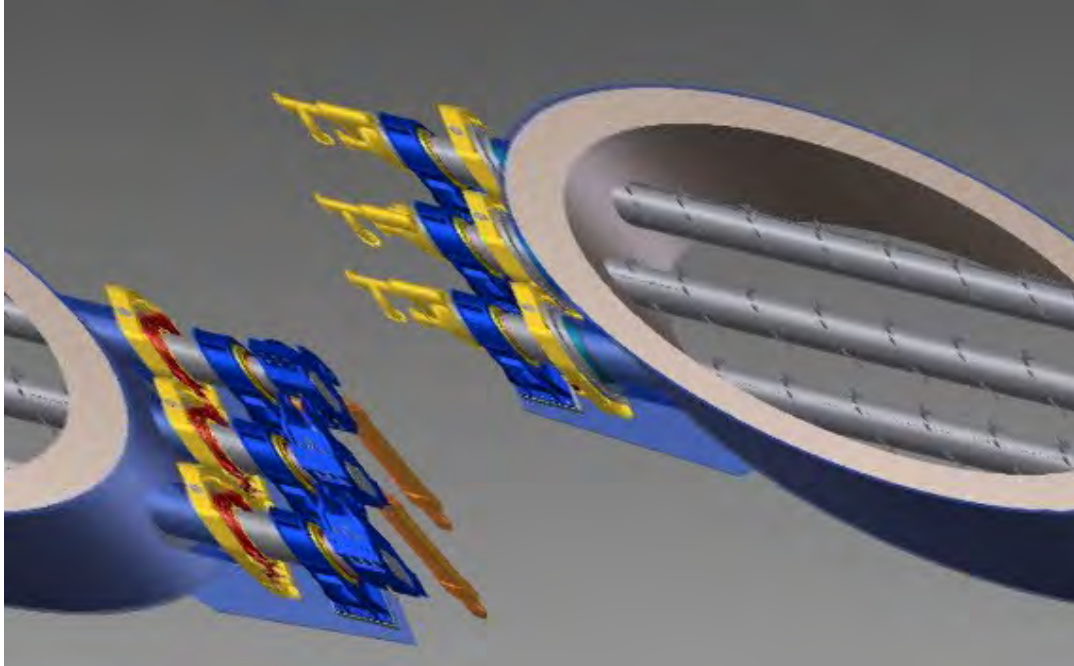
MIDREX shaft

MIDREX



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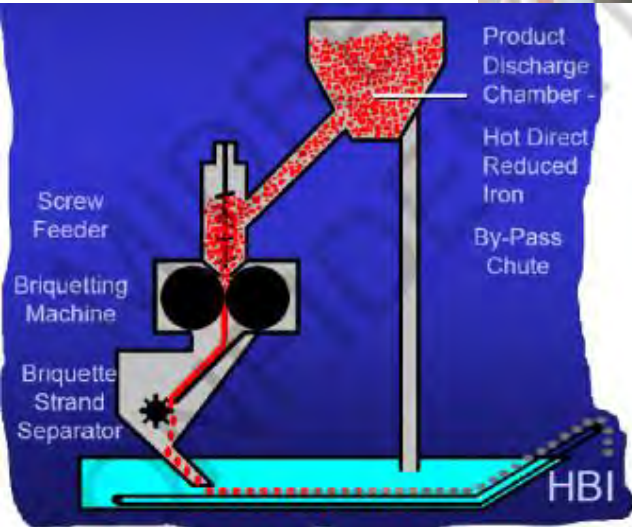
Flow feeder



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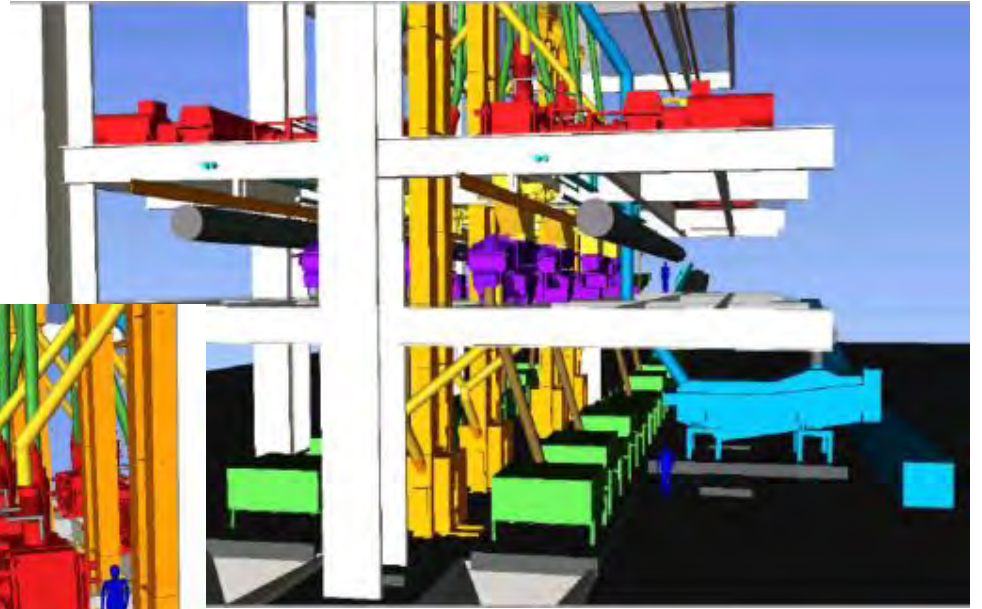
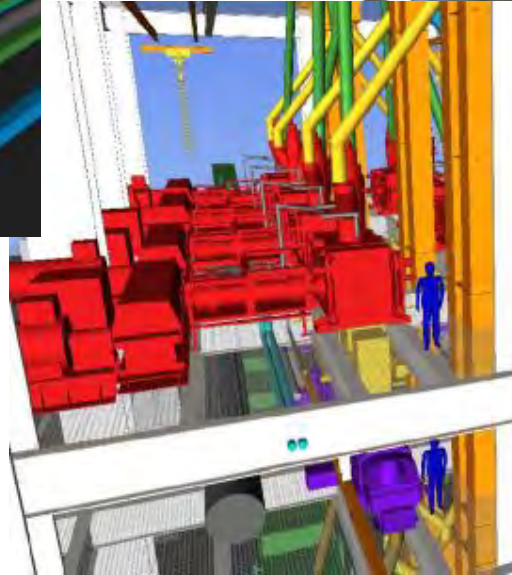
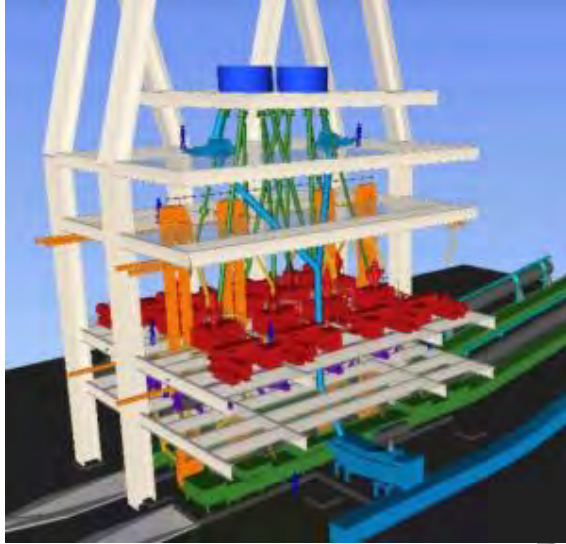
LION DRI

MIDREX



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Briquetting decks Energiron ZR



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Comparison: Reactor

	MIDREX/SVAI	ENERGIRON/Danieli
Coating	After day bins. In case of different oxide qualities no specific coating. Short time for drying.	Prior day bins. Specific coating in case of different oxide qualities. Drying in day bins.
Material feed	Vertical conveyor into charge hopper Central down pipe with upper seal leg Distribution to 16 down pipes into the reactor.	Vertical conveyor into charge hopper. 4 pressurized charging bins. 4 down pipes into the reactor.
Material flow	Upper Middle Burden feeder Lower	Flow feeder Cluster breaker
Material discharge	Central down pipe with lower seal leg Product discharge chamber	Rotary valve 2 pressurized discharge bins
HDRI/CDRI	Retrofittable at briquetting level	Retrofittable before discharge bin
Size of shaft	7,1 m diameter	6,3 m diameter
Tower height	131 m	138,5 m

Comparison: Briquetting

	MIDREX/SVAI	ENERGIRON/Danieli
Briquetting	1 distributing bin 6 (7) Briquetting machines each with 40 t/h.	2 Distributing bins 6 (7) Briquetting machines each with 40 t/h
HBI fines recycling	Hot screening after briquetting and recycling to briquetting machines via vertical conveyor.	Hot screening after briquetting and recycling to briquetting machines via vertical conveyor.
HBI cooling	2 steel plate conveyor belts with spray-cooling. Full flexibility between briquetting machines and cooling conveyors.	2 steel plate conveyor with spray-cooling. Limited flexibility between briquetting machines and cooling conveyors.

Comparison: Process gas

	MIDREX/SVAI	ENERGIRON/Danieli
Reducing gas production	Reformer = Recuperative heat exchanger with endothermic reforming reaction. 600 pipes with Ni-catalyst. Reforming of CH ₄ with CO ₂ from recycled process gas at Ni-catalyst.	Heater = Recuperative heat exchanger. 80 bundles of pipes (Coils) with convection and radiation section. Partial oxidation of CH ₄ with O ₂ before reactor. In-situ reforming of this gas at metallic bulk material in the reduction shaft.
Temperatur/flow rate of reducing gas	Approx. 980 °C (before CH ₄ addition), 380.000 Nm ³ /h	Approx. 970 (before O ₂ addition) °C, 540.000 Nm ³ /h
Top gas cleaning	Approx. 350 °C, .000 Nm ³ /h. Venturi/package scrubber	Approx. 470 °C, 640.000 Nm ³ /h. Heat recovery for CO ₂ removal . Venturi scrubber.
Gas compression	2 serial radial compressors. Approx 60 % production capacity with 1 compressor possible.	2 parallel radial compressors. Approx. 60 % production capacity with 1 compressor possible.
Life time reducing gas production	Replacement pipes every 10 years and catalyst every 5 years.. Replacement of single pipe during Standby-operation possible.	Replacement bundles every 10 years Replacement of single pipe during Standby-operation possible
Gas sealing	Tightening via seal leg and seal gas system .	Tightening via pressure locks

Comparison: Consumption figures

	MIDREX/SVAI	ENERGIRON/Danieli
Oxide input	Approx 1,4 to/to HBI	Approx.1,4 to/to HBI
Natural gas	< 13 MMBtu / to HBI	< 13 MMBtu / to HBI
O ₂	Not necessary	Approx. 60 m ³ / to HBI
N ₂	Not necessary	Approx. 75 m ³ / to HBI
Electric energy	Approx. 125 kWh / to HBI	Approx. 115 kWh / to HBI
Personal years	Approx. 150	Approx. 150